Clinical question.
In patients with suspected ACS (P), does the use of specific imaging techniques (e.g. CT angio/MRI/nuclear/ECHO) (I), compared with not using them (C), increase accuracy of diagnosis (e..g. of ACS) (O)?

Is this question addressing an intervention/therapy, prognosis or diagnosis? Diagnosis

State if this is a proposed new topic or revision of existing worksheet: New topic – no prior worksheet on this topic

Conflict of interest specific to this question
Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? No

Search strategy (including electronic databases searched).
PubMed: key words: computed tomography (CT); echocardiography; MRI; radionuclide imaging (RI); acute coronary syndrome(ACS); chest pain(CP); acute myocardial infarction(AMI); emergency department(ED)

MRI AMI diagnosis n=479, /ED n=13
RI AMI diagnosis n=1446, /ED n=12
Echocardiography AMI diagnosis n=2682, /ED n=45
CT AMI diagnosis n=392, /ED n=12
MRI ACS diagnosis n=71, /ED n=14
RI ACS diagnosis n=56, /ED n=13
Echocardiography ACS diagnosis n=238, /ED n=27
CT ACS diagnosis n=87, /ED n=15
MRI CP diagnosis n=550, /ED n=42
RI CP diagnosis n=1155, /ED n=89
Echocardiography CP diagnosis n=1833, /ED n=116
CT CP diagnosis n=769, /ED n=65

Number of articles meeting criteria:334
Using exclusion critera and manual search including ACC/AHA guideline

• State inclusion and exclusion criteria
Inclusion criteria: Studies which enrolled ED patients with symptoms suggestive of ACS (USA/NSTEMI); non-diagnostic ECGs; negative biomarkers.
Peer reviewed.
Manuscript available to review.
Human studies.
Criteria for studies of MDCT defined positive scan as >50% stenosis.
Clinical follow-up was obtained in all patients concerning the presence of ACS/NSTEMI and a positive clinical outcome was defined using actual clinical standards.

Exclusion criteria: Abstract-only studies. Case reports. Review articles. Studies that assessed imaging in stable CAD not ACS. Studies that did not address diagnosis specifically. Imaging that occurred >24hrs after acute event. Unknown or positive biomarkers at the time of imaging. For CT studies – excluded older generation (16 slice) scanners i.e. used articles that assessed 64-slice multi-detector scanners only.
**Summary of evidence**

**Evidence Supporting Clinical Question**

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All articles are E = Other endpoint, E1=CT angio, E2=MRI, E3=nuclear imaging, E4=echocardiography

**Evidence Neutral to Clinical question**

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All articles are E = Other endpoint, All articles are E = Other endpoint, E1=CT angio, E2=MRI, E3=nuclear imaging, E4=echocardiography

- Number of articles/sources meeting criteria for further review: 15
Evidence Opposing Clinical Question

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All articles are E = Other endpoint, E1=CT angio, E2=MRI, E3=nuclear imaging, E4=echocardiography

REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

ACC/AHA 2007 guideline for ACS{Anderson,2007,e148} showed that stress study to provoke ischemia is recommended in patients with suspected ACS, non-diagnostic ECG and negative cardiac biomarkers. MDCT, SPECT, MR, or echocardiography can be considered as an alternative to stress testing. However, almost evidences in the Guideline were studied in patients with stable CAD and very few in patients with ACS. Therefore, the safety, diagnostic efficacy, and efficiency of imaging techniques including echocardiography, CT, MRI and radionuclide imaging are necessary to evaluate for low-risk acute chest pain in emergency department.

There are 15 articles for the review. Two meta-analysis {Athappan,2009,in Press} and {Vanhoenacker,2007,39} were classified into Level D1 studies. Level D2: 1 meta-analysis and Level D4: 10 studies were supportive to clinical question. Level D3: 1 study was neutral and Level D4: 1 study was opposing to clinical question.

Rionuclide imaging; 7 studies showed sensitivity 71-100%, negative predictive value 97-100% and specificity 67-92%. {Ioannidis,2001,471} (Level D2) showed in meta-analysis that technetium-99m sestamibi imaging appear to have very good diagnostic performance with a similar sensitivity (89%) and specificity (77%) profile comparing with echocardiography and for selected low- and moderate-risk patient groups. {Candell-Riera,2007,1662} (Level D3) showed the sensitivity (100%) of radionuclide tests is higher, but their widespread use does not appear warranted because their positive predictive value (27%) and incidence of events are low (neutral evidence). Level D4 3 studies {Conti,2005,894, Forberg,2009,12, Gregoire,1990,42E} were supportive for using SPECT. Stress SPECT imaging showed high sensitivity (71-100%) and negative predictive value (92-100%) for ruling out acute coronary syndrome in low-risk. However, due to low positive predictive value and radiation exposure, SPECT imaging may be recommended for additional method to the conventional diagnostic tools.

MDCT imaging; 6 studies reported high sensitivity 77-100%, negative predictive value 98-100% and specificity 82-92% Budoff et al. {Budoff,2006,1761} in AHA scientific statement showed Class IIa, Level of evidence B recommendation for MDCT use in low-risk patients for evaluation of obstructive CAD in symptomatic patients. 64 slice machines have sensitivities 82-100% and specificities 82-98% for detecting significant coronary stenosis. {Vanhoenacker,2007,39} (Level D1) showed in meta-analysis that 9 studies (one randomized and 8 prospective cohort studies) including 566 patients showed pooled sensitivity 95% and specificity 90%. MDCT of the coronary arteries performs good to excellent in the diagnosis of coronary artery disease in the acute setting and it can be used for early exclusion of NSTEMI or UAP in patients in the emergency department. Recently, another meta-analysis was reported {Athappan,2009,in Press}. This study included 1 randomized, 1 retrospective and 14 prospective cohort studies. 16 studies totaling 1119 patients with acute chest pain of low to intermediate risk during emergency department evaluation were analyzed. Data showed the diagnostic odds ratio was 191, the sensitivity 96%, and specificity 92% for the detection of significant coronary artery stenosis. MDCT has an excellent diagnostic accuracy and the rapid triage power in detection of significant coronary artery stenosis in patients with acute chest pain of low to intermediate risk of acute coronary syndrome in emergency department. Level D4: 4 studies {Gallagher,2007,125, Hoffmann,2009,1642, Hoffmann,2006,2251, Rubinstein,2007,1762} were supportive for using MDCT. The advantages of MDCT are excellent resolution of coronary anatomy and short study time. MDCT shows the high negative predictive value, however, the positive predictive value in determining whether a given plaque or stenosis is
causing the sign and symptoms of ACS is less clear. Disadvantages are high radiation dose (8 to 24 mSv), contrast dye exposure, motion artifact, and necessity to achieve a slow, regular heart rate. [Athappan, 2009, in press]. Recently, new protocols (prospective ECG-triggering) or radiation exposure-reducing technology (more than 256 slice scanners or dual source scanner) has been achieved acceptable radiation exposure; as low as 2 to 3 mSv [Herzog, 2008].

MR imaging: 2 studies for cardiac magnetic resonance (CMR) imaging were reported. Level D4: 2 studies [Cury, 2008, 837, Kwong, 2003, 531] were supportive for CMR. CMR has the capability of assessing cardiac function, perfusion, and viability in the same setting; cine wall motion (regional contraction can be assessed using dobutamine CMR), rest first-pass myocardial perfusion (adenosine stress perfusion test, microvascular obstruction), LV wall thickness analysis, delayed-enhancement imaging (more sensitive in detection subendocardial MI), T2W images (myocardial edema), and coronary MR angiography (proximal coronary stenosis). Disadvantages of CMR include long study time, contraindication to the presence of pacemakers/defibrillators and expensive. CMR advantages are excellent resolution of cardiac structure and avoidance of exposure to radiation and iodinated contrast, therefore, for non-ionizing alternatives CMR or echocardiography may be recommended in patients to avoid excessive cumulative radiation doses.

Echocardiography: 5 studies reported sensitivity 74-93% and specificity 65-95%. [Ioannidis, 2001, 471] (Level D2) showed in meta-analysis including 3 studies that rest echocardiography showed sensitivity of 93% and specificity of 66% in 397 patients with normal or nondiagnostic ECGs, appeared to have good diagnostic performance with a similar sensitivity and specificity profile comparing with technetium-99m sestamibi imaging. Level D4: 3 studies, stress echocardiography [Conti, 2005, 894, Iglesias-Garriz, 2005, 1181] and resting echocardiography [Paventi, 2001, 47]. Echocardiography is possible to be detected during ischemia and differential diagnosis is identified. Therefore, resting echocardiography should routine be used in emergency department. Stress echocardiography is helpful in stabilized patients to obtain objective evidence of ischemia, however, showed relatively low sensitivity and specificity, because diagnostic accuracy is dependent on expert performance and interpretation. Exercise stress echocardiography is sometimes not feasible because of the body motion. However, echocardiography is a safe, rapid, cheap, and radiation-free test, therefore, stress echocardiography will be recommended to accurately diagnose acute coronary syndrome in patients with low-risk and no or non-diagnostic ECG changes.

Assessment of risk/benefit:
Immediate imaging techniques including multi-detector CT, echocardiography including resting, contrast, and stress echocardiography, myocardial SPECT imaging or MR imaging are recommended in patients with suspected acute coronary syndrome, low-risk and no or non-diagnostic ECG changes to enhance diagnostic accuracy for unnecessary hospitalization and costs without increase in cardiac events. However, few comparative or randomized studies among those imaging modalities were reported. There have no large-scale, prospective, multicenter studies of diagnostic accuracy performed for the several stress imaging tests. Radiation exposure in radionuclide or MDCT is not mentioned in those studies; therefore, the studies about radiation overdoses and dose reduction method using those imaging techniques in emergency department will be necessary [Herzog, 2008].
Citation List


Level D1, fair study, supportive, meta-analysis including 1 randomized, 1 retrospective and 14 prospective cohort studies. 16 studies totaling 1119 patients with acute chest pain of low to intermediate risk during emergency department evaluation were analyzed. Data showed the diagnostic odds ratio was 191, the sensitivity 96%, and specificity 92% for the detection of significant coronary artery stenosis. MDCT has an excellent diagnostic accuracy and the rapid triage power in detection of significant coronary artery stenosis in patients with acute chest pain of low to intermediate risk of acute coronary syndrome in emergency department.


Class IIa, Level of evidence B recommendation for its use in low-risk patients. 64 slice machines have sensitivities 82-100% and specificities 82-98% for detecting significant coronary stenosis. MDCT is reasonable for the assessment of obstructive disease in symptomatic patients and may help avoid invasive angiography. Radiation exposure during MDCT: 8-13 mSv comparing with CAG doses of 2.1-2.3mSv and nuclear imaging doses of 8-12mSv For CT angiography, use of the higher radiation exposure tests in asymptomatic persons for screening purpose is not currently recommended.


Level D3, Neutral article, poor study, comparative and prospective studies without controls
Rest SPECT, Exercise ECG, and Stress SPECT were performed in patients with low risk chest pain, and showed high negative predictive value, however low positive predictive value.


LOE D4, fair study, supportive article, no control, Comparative study for Exercise echocardiography and Exercise SPECT in 503 patients with low risk chest pain. Ex echocardiography showed higher specificity (95 vs 90%) and PPV (81 vs 67%) than Ex SPECT.

LOE D4, good study, supportive article, Cardiac magnetic resonance (CMR) using new MRI protocol; cine wall motion, rest first-pass myocardial perfusion (FP-MRI), T2W images (myocardial edema), LV wall thickness analysis, and delayed-enhancement imaging (DE-MRI) were compared with standard protocol (cine, perfusion, and DE-MRI) in 64 patients with chest pain, no ECG changes and negative cardiac enzyme. CMR is helpful in differentiation acute from chronic MI by combining late gadolinium enhancement with T2-weighted imaging. New protocol showed 85% sensitivity (standard 85%), 96% specificity (84%), 85% PPV (58%), 96% NPV (95%), and 93% diagnostic accuracy (84%). CMR provided incremental value in the detection of ACS over and above traditional risk stratification, with the changes detected by CMR occurring before the rise in cardiac enzymes. CMR is useful in the setting of delayed presentations in which cardiac enzymes may have returned to normal, whereas abnormalities on T2-weighted CMR can persist for several days.


LOE D4. Supportive and fair article. Confounders likely not accounted for based on very low prevalence of ACS (2/40). Bias likely. Very small sample size. Outcomes are not well identified and described.


Level D4, poor study without control, supportive article, This was a prospective and comparative study of the diagnostic accuracy of myocardial perfusion imaging and multidetector CT in low-risk chest pain 85 patients. The primary outcomes were diagnostic accuracy to detect ACS and 30 day MACE. CTA is comparable to nuclear stress imaging for low-risk chest pain patients; sensitivity 86% vs 71%, specificity 92% vs 90%, NPV 99% vs 97%, PPV 59% vs 38%.


LOE D4, Fair and Supporting article. SPECT was performed in 45 patients with unstable angina and showed higher sensitivity 96% and specificity 79% to detect significant coronary artery disease comparing with ECG changes sensitivity 35% and specificity 68%.


LOE D4, good article, prospective, nonrandomized, cohort study without control, supportive article. 368 patients with low-risk acute chest pain in ED were examined using MDCT in the weekday daytime after exclusion. Diagnostic accuracy for coronary stenosis (>50%) have a sensitivity of 77%, specificity 87%, PPV 35% and NPV 98%. A limited sensitivity (77%) in this study had false negative findings in small vessels.


LOE D4, poor study without controls, supportive article, a blinded prospective study for MDCT in 103 patients with low risk chest pain. Overtriage and missed diagnosis of ACS remain unacceptably high using standard method in ED. There is a clear need to improve the early triage of patients with acute chest pain. MDCT, Sensitivity 1.0, specificity 82%, PPV 47%, and NPV 1.0, may be useful for improving early triage.

LOE D4, poor study, Opposing article. Stress echocardiography (exercise, dobutamine or dipyridamole) for 487 patients with low risk chest pain were performed to detect ACS. However, diagnostic accuracy was performed only for 78 patients with coronary angiography. Those data showed sensitivity 74%, specificity 65%, PPV 86%, and NPV 46%. Stress echocardiography is an insensitive test.


LOE D2, fair and supportive article. Meta-analysis for imaging techniques including only 3 studies of rest echocardiography and 5 studies of sestamibi imaging in ED. Rest echocardiography showed sensitivity of 93% and specificity of 66% in 397 patients with normal or nondiagnostic ECGs. Sample size of studies combined in the meta-analysis is relatively small. Stress echocardiography data in ED was not available in this meta-analysis. Technetium-99m sestamibi scanning in 4 rest imaging and 1 stress scanning also showed sensitivity of 89% and specificity of 77% in 1571 patients. For selected low- and moderate-risk patient groups, echocardiography and technetium-99m sestamibi imaging appear to have very good diagnostic performance with a similar sensitivity and specificity profile. More evidence should be accumulated on their performance specifically in the ED setting.


LOE D4, fair study, supportive article, MRI including myocardial perfusion, regional function, wall thickening, and delayed enhancement for 161 patients with chest pain without STEMI in ED showed sensitivity of 84% and specificity of 85% for detecting ACS defined as 70% coronary stenosis or positive stress test within 8 weeks. Detection of regional wall motion abnormalities was the most powerful part of CMR. CMR imaging may identify ACS more accurately than conventional markers. There were not enough data for diagnostic accuracy. Limitation of this study was inability to differentiate acute from chronic myocardial infarction.


LOE D4, good study without control, supportive article. Comparative study between rest echocardiography and rest SPECT in 470 patients with low or moderate risk showed no differences for diagnostic accuracy, sensitivity 75 vs 75%, specificity 88 vs 90%.


LOE D4, fair study without control, supportive article, MDCT was performed in 58 patients for chest pain with no ECG change or elevated biomarkers. Diagnostic sensitivity was 100%, specificity 92%, NPV 100%, PPV 87%, accuracy 95%. Negative CTA predicted a low rate of major adverse CV events (NPV97%).


LOE D1, meta-analysis, good study, supportive article. Meta-analysis was performed to review the literatures (2000-2007) of Multi-detector computed tomography angiography (MDCTA) for ACS with NSTEMI or unstable angina. Nine studies (one randomized and 8 prospective cohort studies) including 566 patients showed pooled sensitivity 95% and specificity 90%. MDCTA of the coronary arteries performs good to excellent in the diagnosis of coronary artery disease in the acute setting and it can be used for early exclusion of NSTEMI or UAP in patients in the emergency department.